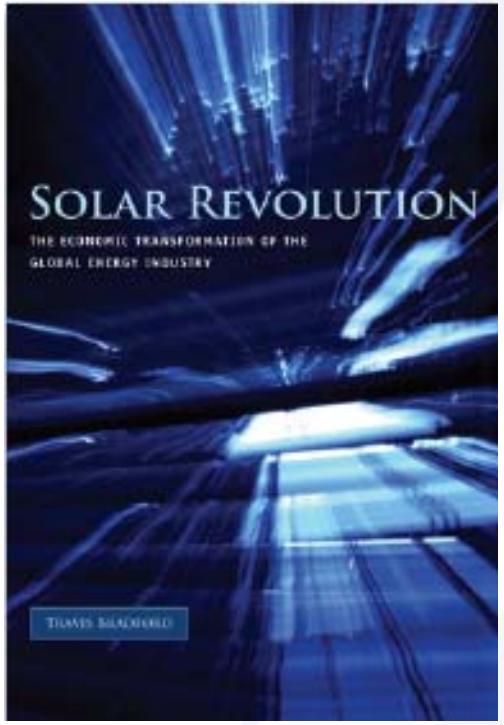
World PV Market Update and Photovoltaic Markets, Technology, Performance, and Cost to 2015

Travis Bradford

Solar Market Outlook

Solar Revolution

- From MIT Press – *September 2006*
- Based on Economic-only Projection Models
- Not only will we reach grid-parity, but permanently exceed it
- Disruptive Technological Transformation = HUGE BUSINESS OPPORTUNITY



Prometheus Institute

Meeting the Need for Information

The Prometheus Institute for Sustainable Development

Institute Research Products
2008

Prometheus Institute

World PV Market through 2007

Global Producers - 2007

	2001	2002	2003	2004	2005	2006	2007	*06 to 07 Growth*	Capacity YE07	Capacity YE08
US	100.3	120.6	103.0	138.7	153.1	179.6	266.1	*17.3%*	318.0	616.0
Japan	172.4	252.6	365.4	604.0	833.0	926.9	920.0	*11.3%*	1,482.5	1,707.5
Europe	73.9	122.1	200.2	311.8	472.6	680.3	1,062.8	*43.9%*	1,742.4	2,916.0
ROW	25.9	43.5	75.4	141.5	312.5	687.0	1,484.1	*119.8%*	2,633.0	5,009.5
	372.5	538.7	743.9	1,196.0	1,771.2	2,473.7	3,733.0	*50.9%*	6,175.9	10,249.0
% Thin Film	4.8%	3.2%	5.1%	5.1%	5.4%	6.9%	10.0%			

All figures in MW-dc of Cells

- **50% global growth surprisingly strong.**
  - **Due to more polysilicon available than commonly thought.**
- **Production moving to Asia – China and Taiwan**
- **US production will grow rapidly in 2008 and beyond**
  - **1 GW by 2010???**

US Producers - 2007

Company	2001	2002	2003	2004	2005	2006	2007	*06 to 07 Growth*	Capacity YE07	Capacity YE08
First Solar	-	-	3.0	6.0	20.0	60.0	120.0	*100%*	135.0	150.0
United Solar OVONICS	3.8	4.0	7.0	14.0	22.0	28.0	48.0	*71%*	60.0	120.0
Solarworld CA (Shell Solar)	39.0	46.5	52.0	62.0	42.0	35.0	35.0	*0%*	45.0	100.0
BP Solar	25.2	31.0	13.4	14.2	22.6	25.6	27.7	*8%*	40.0	40.0
Evergreen Solar	-	1.9	2.8	6.0	14.0	13.0	16.4	*26%*	16.0	86.0
Schott Solar	5.0	5.0	4.0	10.0	13.0	13.0	10.0	*-23%*	15.0	15.0
Global Solar	-	-	2.0	1.0	1.0	2.5	4.0	*60%*	5.0	40.0
Other	27.3	32.2	18.8	25.5	18.5	2.5	5.0	*100%*	2.0	65.0
Total	100.3	120.6	103.0	138.7	153.1	179.6	266.1	*48%*	318.0	616.0
w/o First Solar					*133.1*	*119.6*	*146.1*	*22%*	*183.0*	*466.0*

All figures in MW-dc of Cells

- **US production growth almost completely driven by First Solar - $2.45 per Watt selling price**
- **Polysilicon shortage pinched majors**

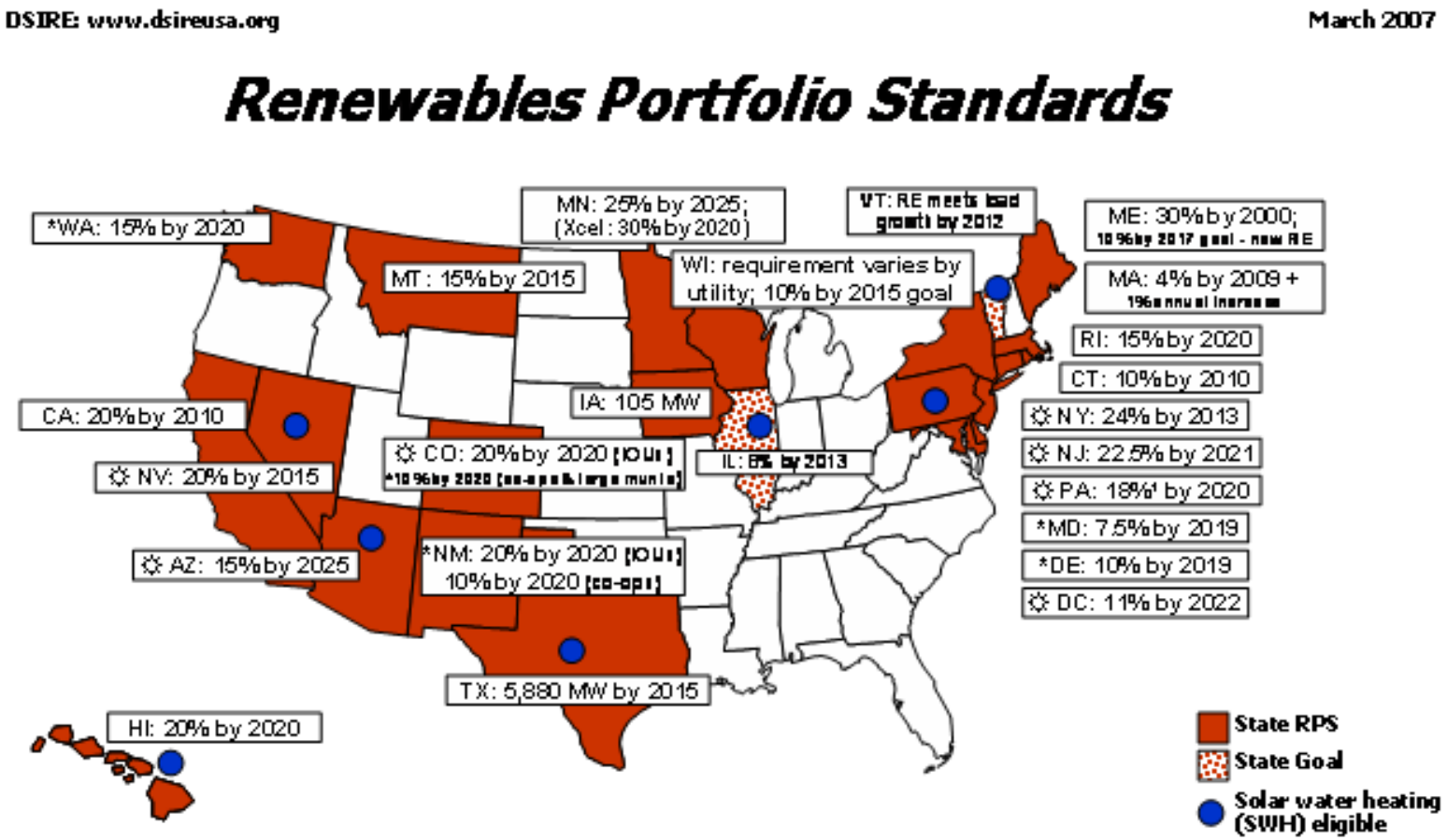
Prometheus Institute

US Policy Driving PV Markets

US State Legislation

State	Status	Marketsize Thru 2015	Yr to Start Program
Arizona	ACC has secured funding, final rules in place by end of 2007	1,000 MWs	2007
California	IOU program is place, municipal program in place by end of 2007	3,000 MWs	2007
Colorado	Passed RPS, started program, looking to double RPS	50 MWs	2006
DC	Passed RPS, putting rules in place by end of 2007	30 MWs	2008
Hawaii	High electricity prices, smaller systems, state tax credits	55 MWs	Current
Nevada	Passed RPS, current program needs to be fixed	145 MWs	Current
New Jersey	Program increased to 1,500 MWs, rules in place by end of 2007	1,500 MWs	Current
New York	Passed RPS, more legislation coming, program start by 2008	25 MWs	2007
North Carolina	Reauthorized 35% Tax Credit, $2.5m cap through 2011	35 MWs	Current
Northeast States	Existing, subsidy underutilized, need some rule changes	35 MWs	2007
Pennsylvania	Passed RPS, announced $200MM additional dollar	750 MWs	Current
Texas	$500MM legislation going through legislature, Austin 100 MW	200 MWs	2007
AK, DE, FL, IL, MN, MI, MT, NM, OH, OR	Existing programs, generally small. Need some work on interconnection, net metering, customer awareness, low rebates	300 MWs	2007+
Totals	**Solar balances rural central generation from Wind, Geo, etc**	**~7,200 MWs**	**$35B market**

RPSs adding to Demand



Prometheus Institute

Federal Legislation - EPAct 2005

- **First Residential Tax Credit in 20 Years**
  - 30% capped at $2,000
  - Available for PV and DSWH
  - Only 2 years
- **Expands Commercial Credit**
  - 30%, no cap
  - Covers all equipment and installation costs
  - Available for all technologies
  - Only 2 years

Proposed Federal Legislation –

Securing America's Energy Independence Act (HR 550, S 590)

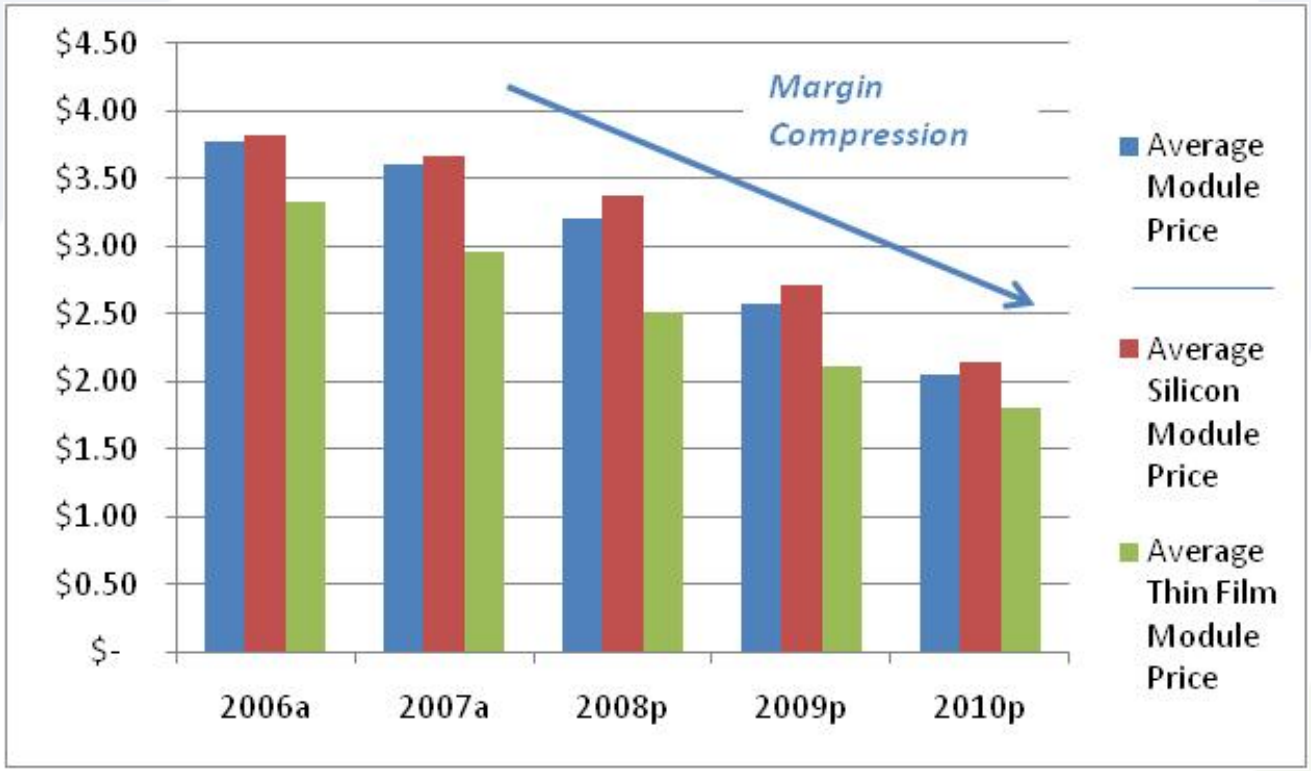
- Extend the Federal tax credits to 10 years (through 2016)
- Thermal remains at 30%
- PV credit modified to fixed $/W
  - $3.00/watt
- Remove the residential cap of $2,000
- Provide AMT relief
- Provide 3-year accelerated depreciation
- Retroactive to January 1, 2008

Outlook of Current and Future PV Markets

Cell Supply– Growing Quickly

- **Massive Plants expected through 2010:**
  - Sharp – 1.6 GW (2010)
  - Kyocera – 500 MW (2009)
  - Sanyo – 350 MW (2008)
  - First Solar – 450 MW (2009)
  - United Solar – 300 MW (2010)
  - SunPower – 500 MW + (2010)
  - Suntech – 1 GW + (2010)
  - Q-Cells – 1 GW? (2010)
  - Conergy – 250 MW (2008)
  - Ever-Q – 300 MW (2010)
  - Solland – 500 MW (2010)
  - Schott – 480 MW (2010)
  - SolarWorld – 1 GW (2010)
  - Yingli – 600 MW (2010)
  - Motech – 450 MW (2010)
  - Trina – 660 MW (2010)
  - E-Ton – 300 MW (2009)
  - JA Solar – 275 MW (2008)

Module Price Forecasts



Prometheus Institute

2010 Expectations

- **12 GW ++** of module production capacity
  - 25 - 35% thin film
- Demand at today's prices – **3.5 GW**
- System prices cut in half by 2010
  - **$4.00/ Watt** installed to equilibrate demand
  - Delivered PV electricity prices
    - **< 10 cents**/ kWh in best locations
    - < 5 cents/ kWh after subsidy
- Demand becomes ***highly inelastic*** there
- Policy changes are wildcard
  - Direct subsidies will have largest price impact

2015 Expectations

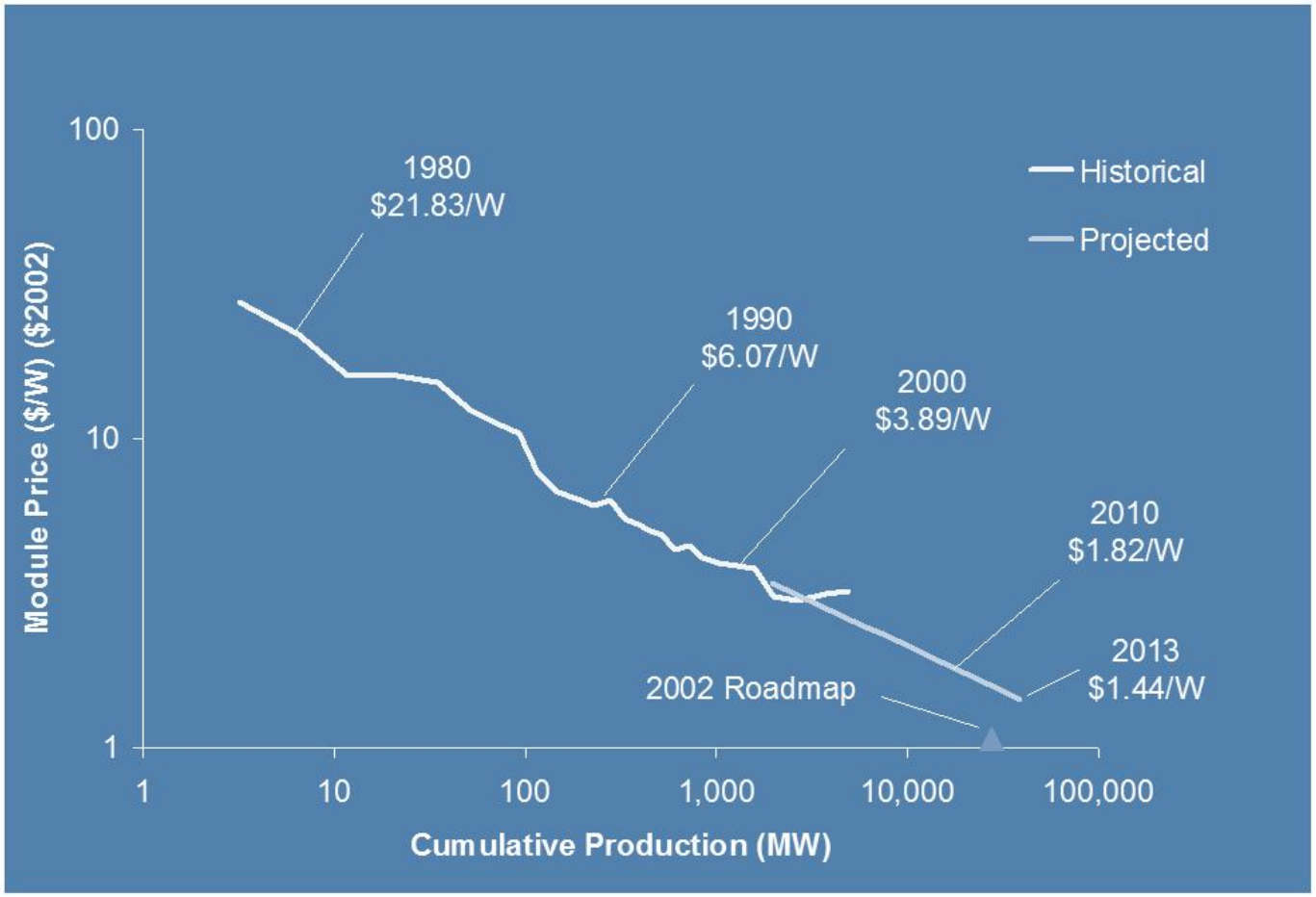
Market Size Across Applications	Grid-Tied Residential	Grid-Tied Commercial	Grid-Tied Utility	Special Applications	Off-Grid Applications	Total
2007	**40%** *(1.2 GW)*	**30%** *(0.9 GW)*	**10%** *(0.3 GW)*	**0%** *(0 GW)*	**20%** *(0.6 GW)*	***3 GW***
2010	**25%** *(1-2.5 GW)*	**35%** *(1.4-3.5 GW)*	**25%** *(1-2.5 GW)*	**0%** *(0 GW)*	**15%** *(0.6-1.5 GW)*	***4-10 GW***
2015	**20%** *(8-12 GW)*	**30%** *(12-18 GW)*	**35%** *(14-21 GW)*	**5%** *(2-3 GW)*	**10%** *(4-6 GW)*	***40-60 GW***

- **Market Economics takes over at**
  - **$3 per Watt installed for central systems**
  - **$4 per Watt for distributed systems.**

- **Structural inefficiencies will still bottleneck, including**
  - **Policy design – Rebate vs. feed-in tariff**
  - **Net Metering, interconnection, and rate design**
  - **Grid integration, transmission, and available labor**

How PV Technologies Economically Compete

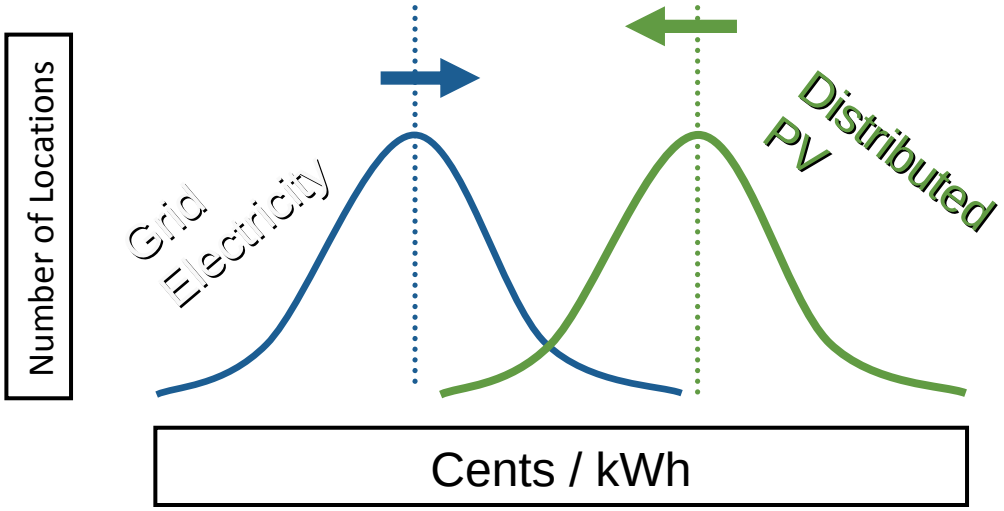
Grid Parity Coming Soon



Prometheus Institute

What is Grid Parity ?

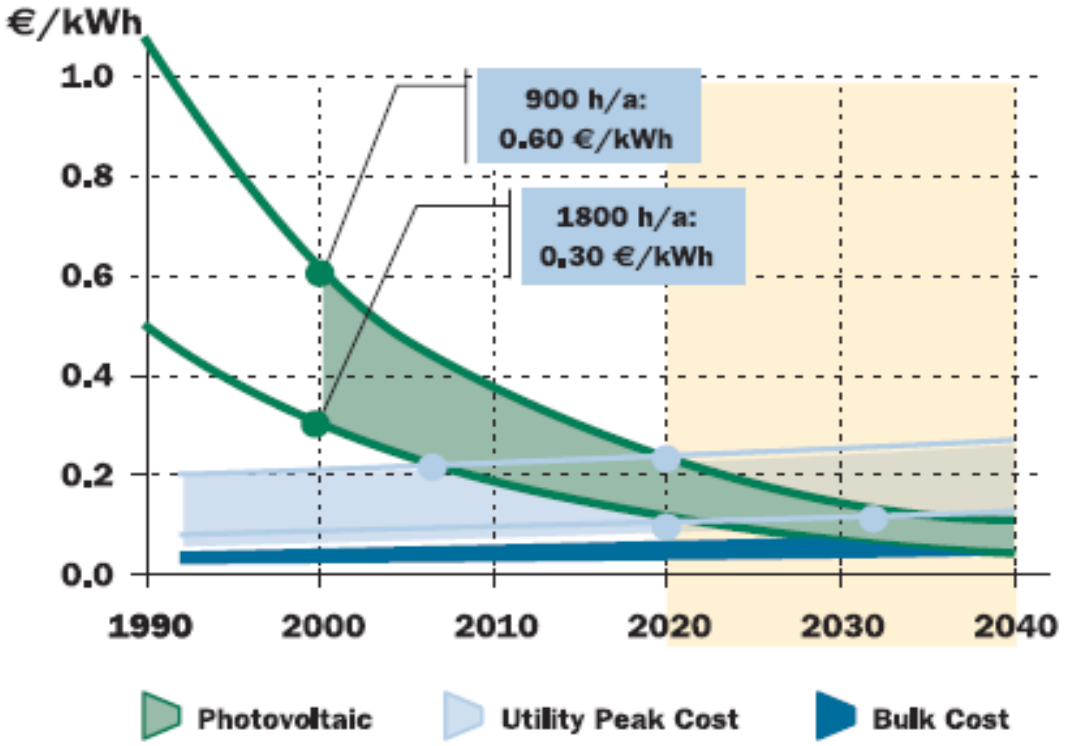
- Assumes Distributed Solar Deployment (not Centralized)
- Range of PV Prices versus range of local grid-prices



- When do we achieve grid-parity? How do we get there?

Prometheus Institute

EPIA Scenario - Europe

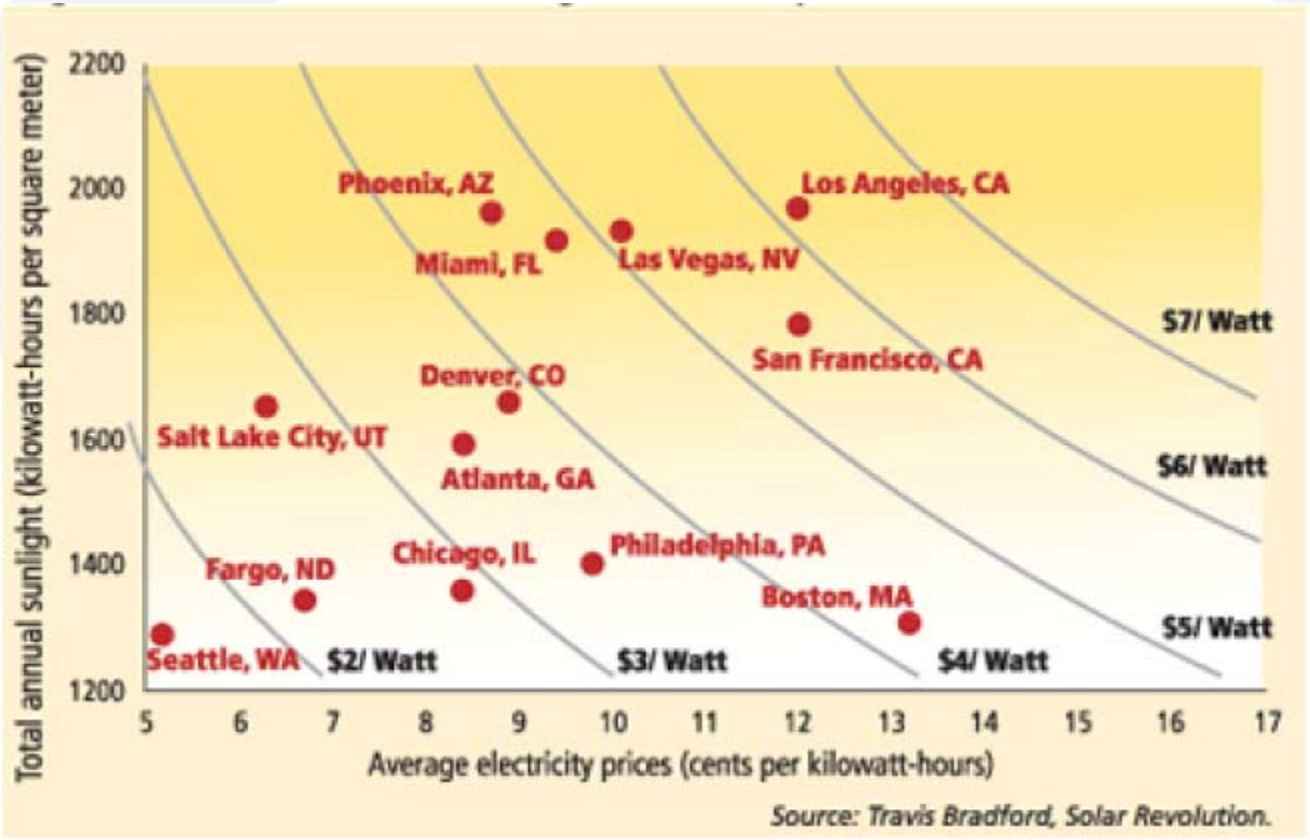


Source:
European Commission/ EPIA

- **By 2020, 20-30% of European energy could be met cost-effectively with solar**
  - **Versus forecast market penetration of 1.1%**

Prometheus Institute

Iso-Cost Curves for Solar



- **Many Markets will become cost effective soon.**

Where to find an edge?

Cost of System –

Components

Installation

Transmission

Incentives –

Rebates/ Feed-in tariffs

Tax Credits

Accelerated Depreciation

Home Mortgage Interest Ded.

Dollars / Watt

Today:

$6 – 10 per Watt (unsubsidized)

Financing –

Real Interest Rates

Term

Residual Value

Performance –

Amount of Sun *(Insolation)*

Optimal Placement

System Losses

Maintenance

Operating Costs

Cents / kWh

Today:

$0.15 - $0.45 per kWh

(unsubsidized)

Prometheus Institute

The Future of Energy

- PV represents an inevitable economic shift.
  - Reduced risk and cost for cleaner, renewable energy.
  - Developed and developing country applications.
- No technical hurdles, only scale of production.
- Time horizons:
  - 30-50 years to provide substantial amount of world energy
  - 10-15 years to supply a major portion of new generation assets
  - ~5 years to economic obviousness
- Exciting industry growth –
  - 30-40% per annum for decades.
  - $20 billion per year to > $1 trillion within 30 years?

Thank You !

Prometheus Institute